

Soil Conservation Service

Huron, South Dakota TECHNICAL NOTE

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DENNIS SHOUP Conservation Agronomist January 14, 1992

### REDUCED TILLAGE CROP ROTATION STUDY

Enclosed is a copy of the above titled paper written by C. E. Stymiest and B. A. Swan. C. E. Stymiest is the South Dakota West River Extension Agronomist and B. A. Swan is a member of his staff.

The paper compares the various reduced tillage systems on plots on the Bonnie Silvage farm near Hayes, South Dakota. It includes the yields for 1991, the economics on each system for 1991, and the average net income for the last three years for each system.

The comments, discussion of results, and summary sections of this paper provide some insight on why the various systems are performing as observed.

SHERIDAN I. DRONEN

State Resource Conservationist

Enclosure

File under: Agronomy

### REDUCED TILLAGE CROP ROTATION STUDY Bonnie Sivage Farm Hayes SD. C.E.STYMIEST & B.A.SWAN

Objectives: 1) To maintain at least 30% residue cover on the soil surface at all times. 2) Evaluate the net income from each rotation each year. 3) Evaluate changes in soil tilth, weed present and disease occurrence.

Experimental Design: The crop rotations include 5 cropping sequences which vary from 2 to 5 years in duration. The cropping sequences have been maintained from 1987 to the present. The rotation are replicated 4 times in a randomized complete block design.

South Dakota Wheat Commission, SDSU Agricultural Funding: Experiment Station and SDSU Cooperative Extension Service.

#### Rotations:

A: Winter Wheat / Summer Fallow

A combination of herbicides and tillage are being used to maintain a 30 percent soil residue cover.

B. Winter Wheat / Millet

A continuous cropping rotation planted no-till and maintains excellent soil protection. Herbicides are used to control weeds.

C. Winter Wheat / Milo / Millet / Barley

A continuous cropping system that includes 1 year of row

- crop and 3 years of small grains.

  D. Winter Wheat / Milo / Oats / Winter Wheat / Summer Fallow The longest rotation that includes reduced tillage methods of growing small grains and row crop as well as a summer fallow period.
- E. Winter Wheat / Milo / Summer Fallow The standard Ecofallow rotation which has significant yield increases over conventionally planted grain sorghum in past research.

#### Comments:

Winter wheat crop rotations are dependent on fall and spring moisture to develop full yield potential. The fall of 1990 was extremely dry during September and October. The winter wheat planted on summer fallow germinated and emerged uniformly because there was moisture near the surface in the reduced tillage summer fallow. The winter wheat no-till planted into small grain and millet stubble did not germinate until late in the fall and the stand was thin in the fall. As a result of the dry weather in the fall the stubble planted wheat had a slow start in the spring. The above normal moisture received during April through the first half of June helped the crop develop yield potential (table 1.).

Table 1. Rot Crop	reduce	d tillage Crop	e crop ro	otation Crop	study at	Hayes Crop	SD.	the
A W.Wheat	46.0	Fallow						
B W.Wheat	31.9	Millet	33.7					
C W.Wheat	32.0	Milo	26.3	Millet	32.9	Barley	52.2	
D W.Wheat	49.8	Milo	39.9	Oats	62.4	W.Whea	t 36.0	
Fallow E W.Wheat	47.0	Milo	33.2	Fallow				

### Discussion Of Results:

The rotations have been maintained under reduced and no-tillage methods from 1987 through the present. The crop yields and the cost of crop production has been recorded each year. The cost of production and income for the 1991 crop is listed in this report. The 3 year yields were also used to make long term comparisons with 1991. The 3 year averages are more meaningful than 1 years data. This point is demonstrated in rotation D. During 1991 this rotation had an excellent return of \$34.34 per acre. Rotation D. during the period 1989-1990-1991 had a 3 year average net income of \$14.88 per acre. The changes in prices received for each crop has a major influence on which rotation has an economic advantage. An example of this would be the price of millet has remained at a historical low with an average of 3 cents per pound. If the price of millet increased to 5 cents per pound rotations including millet would look much better.

ROTATION A.				
WINTER	WHEAT	1	SUMMER	FALLOW
200 200	4.44	1.0		

	Cost /A.	1991 Winter Wheat Crop After Fallow
\$	7.85	Reduced Tillage Planting Sept. 1990
	5.25	1 Bu./A. TAM 107 Winter Wheat Seed
	7.56	6 gal/A.(10-34-0) Starter Fertilizer
	6.48	Ally + 2,4-D ester Applied May 1991
	17.20	Harvesting 46 Bu./A. Winter Wheat
	17.00	Land Charges 1991
	61.59	Total Cost Of Production 1991

# ROTATION A WINTER WHEAT / SUMMER FALLOW

	Cost / A.				
\$	5.55	1 qt./A. Atrazine	Fall Appli		
	6.48	10 ounces /A. Rou	indup May 19	91	
	4.50	June Tillage		004	
	3.82	2,4-D ester Appli			
	6.45 17.00	10 ounces /A. Rou Land Charges	maup Sept.	1991	
	43.80	Total Cost Of 199	1 Summer Fa	llow	
		ROTATION A ECON- WINTER WHEAT			
	Inco	me		enses	
		Def. Payment	61.59	Cost Of	Wheat Crop
	119.60	Sale Of Wheat	2.73	Cost Of	Set Aside
	20.000		43.80	Cost Of	Fallow
	158.70	Total Income	105.39	Total C	ost Of Prod.
	53.3	1 Dollars Income P	er 2 Years		
	26.6	6 Dollars Income P	low Vone In	1991	
		a parrare rucome r	er rear In	T 2 2 T	
	23.2	1 Dollars 3 Year A  ROTA' WINTER WHEAT	verage Inco	me Per Ye. LET	ar
\$	Cost / A.  6.48 7.85 5.25 7.25 6.00 6.29 14.50 17.00	ROTA' WINTER WHEAT 1991 Winter Whea  10 ounces /A. Rou No-Till Planting 1 Bu./A. TAM-107 6 gal/A.(10-34-0) Broadcast Nitroge Ally+2,4-D ester Harvest 32 Bu./A. Land Charges 1991	rION B / PROSO MILE INCOME INC	LET r Millet 990 heat rtilizer r Fall 199	
\$	Cost / A.  6.48 7.85 5.25 7.25 6.00 6.29 14.50	ROTA' WINTER WHEAT 1991 Winter Whea  10 ounces /A. Rou No-Till Planting 1 Bu./A. TAM-107 6 gal/A.(10-34-0) Broadcast Nitroge Ally+2,4-D ester Harvest 32 Bu./A.	rION B / PROSO MILE INCOME INC	LET r Millet 990 heat rtilizer r Fall 199	
ş	Cost / A.  6.48 7.85 5.25 7.25 6.00 6.29 14.50 17.00	ROTA' WINTER WHEAT 1991 Winter Whea  10 ounces /A. Rou No-Till Planting 1 Bu./A. TAM-107 6 gal/A.(10-34-0) Broadcast Nitroge Ally+2,4-D ester Harvest 32 Bu./A. Land Charges 1991 Total Cost Of Pro	rion B / PROSO MIL t Crop After Indup Sept 1 Of Winter W Wheat Seed Starter Fertilize Applied May Winter Wheat duction	LET r Millet 990 heat rtilizer r Fall 199 1991	
ş	Cost / A.  6.48 7.85 5.25 7.25 6.00 6.29 14.50 17.00 70.62	ROTA' WINTER WHEAT 1991 Winter Whea  10 ounces /A. Rou No-Till Planting 1 Bu./A. TAM-107 6 gal/A.(10-34-0) Broadcast Nitroge Ally+2,4-D ester Harvest 32 Bu./A. Land Charges 1991 Total Cost Of Pro	rion B / PROSO MIL  It Crop After  Indup Sept 1 Of Winter W Wheat Seed Starter Fertilizer Applied May Winter Wheat  Iduation  FION B / PROSO MIL	LET r Millet 990 heat rtilizer r Fall 199 1991 at	
ş	Cost / A.  6.48 7.85 5.25 7.25 6.00 6.29 14.50 17.00 70.62	ROTA' WINTER WHEAT 1991 Winter Whea  10 ounces /A. Rou No-Till Planting 1 Bu./A. TAM-107 6 gal/A.(10-34-0) Broadcast Nitroge Ally+2,4-D ester Harvest 32 Bu./A. Land Charges 1991 Total Cost Of Pro  ROTAT WINTER WHEAT	rION B / PROSO MILE INCOMINATION B INCOMINATION B Wheat Seed Starter Ferminate Applied May Winter Wheat Induction ION B / PROSO MILE After Winter	LET r Millet 990 heat rtilizer r Fall 199 1991 at	
	Cost / A.  6.48 7.85 5.25 7.25 6.00 6.29 14.50 17.00 70.62  Cost /A.	ROTA' WINTER WHEAT 1991 Winter Whea  10 ounces /A. Rou No-Till Planting 1 Bu./A. TAM-107 6 gal/A.(10-34-0) Broadcast Nitroge Ally+2,4-D ester Harvest 32 Bu./A. Land Charges 1991 Total Cost Of Pro  ROTAT WINTER WHEAT 1991 Millet Crop  1 qt. /A. Atrazin 10 ounces Roundup	rION B / PROSO MIL  It Crop After  Indup Sept 1 Of Winter Winter Winter Fertilize  Applied May Winter When  ION B / PROSO MIL  After Winter  e Applied May	LET r Millet 990 heat rtilizer r Fall 199 1991 at  LET r Wheat all 1990 y 1991	
	Cost / A.  6.48 7.85 5.25 7.25 6.00 6.29 14.50 17.00 70.62  Cost /A.  5.55 6.48 7.85	ROTA' WINTER WHEAT 1991 Winter Whea  10 ounces /A. Rou No-Till Planting 1 Bu./A. TAM-107 6 gal/A.(10-34-0) Broadcast Nitroge Ally+2,4-D ester Harvest 32 Bu./A. Land Charges 1991 Total Cost Of Pro  ROTAT WINTER WHEAT 1991 Millet Crop  1 qt. /A. Atrazin 10 ounces Roundup No-Till Planting	rION B / PROSO MIL  Indup Sept 1 Of Winter W Wheat Seed Starter Fe In Fertilize Applied May Winter Whe  Iduction  ION B / PROSO MIL  After Winter  Applied May Of Millet Jo	LET r Millet 990 heat rtilizer r Fall 199 1991 at LET r Wheat all 1990 y 1991 une 1991	
	Cost / A.  6.48 7.85 5.25 7.25 6.00 6.29 14.50 17.00 70.62  Cost /A.  5.55 6.48 7.85 2.00	ROTA' WINTER WHEAT 1991 Winter Whea  10 ounces /A. Rou No-Till Planting 1 Bu./A. TAM-107 6 gal/A.(10-34-0) Broadcast Nitroge Ally+2,4-D ester Harvest 32 Bu./A. Land Charges 1991 Total Cost Of Pro  ROTAT WINTER WHEAT 1991 Millet Crop  1 qt. /A. Atrazin 10 ounces Roundup No-Till Planting 20 Lbs./A. Sunup	rION B / PROSO MIL  Indup Sept 1 Of Winter W Wheat Seed Starter Fe In Fertilize Applied May Winter Whe  Clon B / PROSO MIL  After Winter  Applied May After Winter  Applied May Of Millet Jo Millet Seed	LET r Millet 990 heat rtilizer r Fall 199 1991 at LET r Wheat all 1990 y 1991 une 1991	
	Cost / A.  6.48 7.85 5.25 7.25 6.00 6.29 14.50 17.00 70.62  Cost /A.  5.55 6.48 7.85 2.00 14.00	ROTA' WINTER WHEAT 1991 Winter Whea  10 ounces /A. Rou No-Till Planting 1 Bu./A. TAM-107 6 gal/A.(10-34-0) Broadcast Nitroge Ally+2,4-D ester Harvest 32 Bu./A. Land Charges 1991 Total Cost Of Pro  ROTAT WINTER WHEAT 1991 Millet Crop  1 qt. /A. Atrazin 10 ounces Roundup No-Till Planting 20 Lbs./A. Sunup Harvesting 33.7 B	rION B / PROSO MIL  It Crop After  Indup Sept 1 Of Winter W Wheat Seed Starter Fertilize Applied May Winter Wheat  ION B / PROSO MIL  After Winter  Applied May Of Millet Ja  Millet Seed u./A. Millet	LET r Millet 990 heat rtilizer r Fall 199 1991 at LET r Wheat all 1990 y 1991 une 1991	
	Cost / A.  6.48 7.85 5.25 7.25 6.00 6.29 14.50 17.00 70.62  Cost /A.  5.55 6.48 7.85 2.00	ROTA' WINTER WHEAT 1991 Winter Whea  10 ounces /A. Rou No-Till Planting 1 Bu./A. TAM-107 6 gal/A.(10-34-0) Broadcast Nitroge Ally+2,4-D ester Harvest 32 Bu./A. Land Charges 1991 Total Cost Of Pro  ROTAT WINTER WHEAT 1991 Millet Crop  1 qt. /A. Atrazin 10 ounces Roundup No-Till Planting 20 Lbs./A. Sunup	rION B / PROSO MILE INCOMINATION B INCOMINATION B / PROSO MILE Applied May Winter Whee Induction ION B / PROSO MILE After Winter  Applied May After Winter  Applied May Millet Je Millet Seed U./A. Millet	LET r Millet 990 heat rtilizer r Fall 199 1991 at  LET r Wheat all 1990 y 1991 une 1991	90

# ROTATION B ECONOMIC SUMMARY WINTER WHEAT / PROSO MILLET

	Inc	ome WINIER WILL	Expe		
0	39.10 82.94 172.59	Sale Of Millet Def. Payment Sale Of Wheat Total Income  10 Dollars Net I: 55 Dollars Net I:	70.62 123.50 ncome Per	Wheat Crop Total Expenses 2 Years	
		50 Dollars 3 Yea			Year
F100 2000	Cost /A.	WINTER WHEAT / 1991 Winter Wh			
Ş	14.40	10 ounces Round No-Till Planti 1 Bu./A. TAM-1 6 gal/A. (10-3 Ally+2,4-D est Harvest 32 Bu. Land Charges 1 Total Cost Of	ng Of Wint 07 Winter 4-0) Start er Applied /A. Winter 991	er Wheat Sept. Wheat Seed er Fertilizer April 1991 Wheat	1990
12.000	Cost /A.	WINTER WHEAT / 1 1991 Milo Crop			
\$	8.60 10.85 10.08 4.75 9.20 13.38 17.00 72.86	2 qt./A. Atraz No-Till Planti 8 gal./A.(10-3 Cultivate Milo Nitrogen Ferti Harvest 26.9 B Land Charges 1 Total Cost Of	ng And See 4-0) Start lizer Appl u./A. Milo 991	d Cost er Fertilizer ied June 1991	
	Cost /A.	WINTER WHEAT / 1991 Millet Cr			
\$	3.65 7.85 2.00 7.56 14.58 17.00 52.64	8 ounces /A. 2 No-Till Planti 20 Lbs./A. Sun 6 gal./A. (10- Harvest 32.9 B Land Charges 1 Total Cost Of	ng Of Mill up Millet 34-0) Star u./A. Mill 991	et Seed ter Fertilizer et	91

	Cost /A.		OTATION C MILO / MILLET / BARLEY op After Millet	
\$	7.56 3.65 18.44	6 gal./A.(10-3 2,4-D Amine Ap Harvest 52.2 B Land Charges 1	Bu./A. Barley 1991	
	Inc	WINTER WHEAT /	E ECONOMIC SUMMARY MILO / MILLET / BARLEY Expenses	
	39.10 Do 44.18 Sc 49.35 Sc 83.52 Sc 299.35 To 50.	ale Of Milo ale Of Millet ale Of Barley otal Income 38 Dollars Net I 50 Dollars Net I	64.95 Wheat Crop 72.88 Milo Crop 52.64 Millet Crop 58.50 Barley Crop 248.97 Total Expenses  Income From The Rotation 1991 Income Per Year For 1991 ar Average Net Income Per Year	
	WINTER Cost /A.	WHEAT / MILO /	OTATION D OATS / WINTER WHEAT / FALLOW Cer Wheat After Fallow 1991	
\$	5.25	1 Bu./A. TAM-1 6 gal./A.(10-3 Ally+2,4-D est		
100700-10000	WINTER Cost /A.	WHEAT / MILO /	OTATION D OATS / WINTER WHEAT / FALLOW S After Milo 1991	
\$	7.85 4.30 3.65	2 Bu./A. Hytes 2,4-D amine Ap		

Harvest 62.4 Bu./A. Oats Crop

Total Cost Of Production 1991

Land Charges 1991

14.48

17.00

42.28

# ROTATION D

WINTER Cost /A.	WHEAT / MILO / OATS / WINTER WHEAT / FALLOW Milo After Winter Wheat 1991
\$ 8.60 10.85 10.08 4.75 9.20 15.98 17.00 76.46	2 qt./A. Atrazine Applied Fall 1990 No-Till Planting Milo + Seed 8 gal./A.(10-34-0) Starter Fertilizer Cultivate Milo Broadcast Nitrogen Fertilizer Harvest 39.9 Bu./A. Milo Land Charges 1991 Total Cost Of Production 1991
WINTER Cost /A.	ROTATION D WHEAT / MILO / OATS / WINTER WHEAT / FALLOW Winter Wheat After Oats 1991
\$ 6.48 7.85 5.25 7.56 12.50 6.29 15.20 17.00 71.65	10 ounces /A. Roundup Sept. 1990 No-Till Planting Of Winter Wheat 1 Bu/A. TAM-107 Winter Wheat Seed 6 gal./A.(10-34-0) Starter Fertilizer 8 gal./A.(28-0-0) Broadcast Nitrogen Ally + 2,4-D ester Applied April 1991 Harvest 36.0 Bu./A. Winter Wheat Crop Land Charges 1991 Total Cost Of Production 1991
WINTER Cost /A.	ROTATION D WHEAT / MILO / OATS / WINTER WHEAT / FALLOW Summer Fallow 1991
\$ 5.55 6.48 4.50 3.82 17.00 37.35	하게 하는 경영식에 하면 하는 이번 이렇게 하는 이렇게 되었다. 이렇게 되었다면 하는 이렇게 하는 이렇게 하면 하는 이렇게 이렇게 하는 이렇게

# ROTATION D ECONOMIC SUMMARY WINTER WHEAT / MILO / OATS / WINTER WHEAT / FALLOW Income Expenses

11100	Jine		
129.48	Sale Of Wheat		Wheat On Fallow
39.10 I	Def. Payment		Milo Crop
67.03	Sale Of Milo	47.28	Oats Crop
78.00	Sale Of Oats	71.65	Wheat After Oats
93.60	Sale Of Wheat	37.35	Cost Of Fallow
		294.59	Total Expenses
Net	Income For Rotation	\$ 171.72	
Net	Income Per 1991	34.34	
Net	Income 3 Year Ave.	14.88	
			5799042900
	WINTER WHEAT /	MILO / F	ALLOW
Cost /A.			
7.85	Reduced Tillage Pl	anting Of	Winter Wheat
5.25	1 Bu./A. TAM-107 W	inter Whe	at Seed
7.56	6 gal./A.(10-34-0)	Starter	Fertilizer
6.29	Ally + 2,4-D ester	Applied	May 1991
	Harvest 47.0 Bu./A	. Winter	Wheat Crop
17.00	Land Charges 1991		
61.35	Total Cost Of Wint	er Wheat	Production 1991
	ромал	TON P	
			ALLOW
~ ! !*	기가에 되었다고 하다 가게 하는 것이 되었다. 그 사람들이 그리고 있다면 하다 그 그 것을 다시	millo / F	- Wheat 1991
Cost /A.	MIIO ALC	er wincer	
10.13	2.5 qt./A. Atrazir	ne Fall Ap	pplied 1990
	No-Till Planting Milo + Seed		
10.08		Starter	Fertilizer
			o <sub>d</sub> a recisioneres
9.20	Broadcast Applicat	lon Of Ni	trogen
		. Milo	
	Land Charges 1991	4 V	1001
76.65	Total Cost Of Mile	Producti	ION 1991
	129.48 3 39.10 1 67.03 78.00 9 3.60 3 39.10 1 466.31 Net	Net Income Per 1991 Net Income 3 Year Ave.  ROTAT: WINTER WHEAT / Cost /A. Winter W  7.85 Reduced Tillage Pl 5.25 1 Bu./A. TAM-107 W 7.56 6 gal./A.(10-34-0) 6.29 Ally + 2,4-D ester 17.40 Harvest 47.0 Bu./A 17.00 Land Charges 1991 61.35 Total Cost Of Wint  ROTAT: WINTER WHEAT / Cost /A. Milo Aft  10.13 2.5 qt./A. Atrazir 10.85 No-Till Planting M 10.08 8 gal./A.(10-34-0) 4.75 Cultivate Milo 9.20 Broadcast Applicat 14.64 Harvest 33.2 Bu./A 17.00 Land Charges 1991	129.48 Sale Of Wheat 76.46 39.10 Def. Payment 76.46 67.03 Sale Of Milo 47.28 78.00 Sale Of Oats 71.65 93.60 Sale Of Wheat 37.35 39.10 Def. Payment 294.59 466.31 Total Income  Net Income For Rotation \$ 171.72 Net Income Per 1991 34.34 Net Income 3 Year Ave. 14.88  ROTATION E WINTER WHEAT / MILO / FR Cost /A. Reduced Tillage Planting Of 5.25 1 Bu./A. TAM-107 Winter Wheat 7.56 6 gal./A. (10-34-0) Starter 6.29 Ally + 2,4-D ester Applied 17.40 Harvest 47.0 Bu./A. Winter 17.00 Land Charges 1991 61.35 Total Cost Of Winter Wheat  ROTATION E WINTER WHEAT / MILO / FR Cost /A. Milo After Winter Wheat 17.00 Land Charges 1991 61.35 Total Cost Of Winter Wheat 19.35 No-Till Planting Milo + See 10.08 8 gal./A. (10-34-0) Starter Cultivate Milo 9.20 Broadcast Application Of Nil Harvest 33.2 Bu./A. Milo Land Charges 1991

# ROTATION E WINTER WHEAT / MILO / FALLOW

	WINTER WHEAT / MILO / FALLOW
Cost /A.	Summer Fallow 1991
\$ 3.82	2,4-D ester Applied May 1991
4.50	Tillage Late June 1991
6.48	10 ounces /A. Roundup
17.00	Land Charges 1991
31.80	Total Cost Of Summer Fallow

## ROTATION E ECONOMIC SUMMARY WINTER WHEAT / MILO / FALLOW

Income	Expenses
122.20 Sale Of Wheat	61.35 Winter Wheat Crop
55.78 Sale Of Milo	76.65 Milo Crop
39.10 Def. Payment	31.80 Summer Fallow
217.08 Total Income	169.80 Total Expenses
Net Income From Rotation	\$ 47.28
Net Income Per Year 1991	15.76
3 Year Average Net Income	20.92

### Summary:

The objective of maintaining adequate crop residue to be in conservation compliance has been accomplished in rotations A,B,C and D. Rotation E has a marginal amount of milo and wheat straw residue left after the summer fallow period. There has been 20 to 30 percent soil cover after planting of the winter wheat crop. There has been no serious weed or disease problems identified in the rotations. The annual weeds have become less of a problem in all rotation except the winter wheat / millet rotation.

The soil organic matter had an average test of 2.53 percent in the top 6 inches of soil in 1987 and the same plots averaged 3.44 percent in the top 6 inches in the fall of 1991. The reduced tillage crop rotations have been good for the soil during this period of time.

The economic summary would indicate the 3 year average would favor the rotations containing more wheat. The effects of the long term rotations are just starting to develop and longer term research will be necessary to evaluate these effects.